Science of the Total Environment 654 (2019) 418–429

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

The impact of political, socio-economic and cultural factors on implementing environment friendly techniques for sustainable land management and climate change mitigation in Romania

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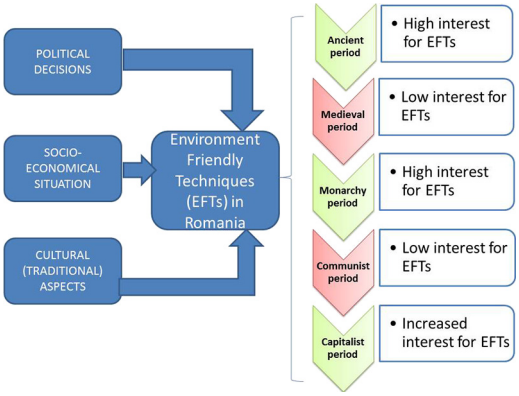
HIGHLIGHTS

- Climate change is evident in Romania, particularly increasing number and intensity of extreme climate events
- Environment friendly techniques (EFTs) are sustainable tools to cope with climate change effects
- In past eras, Romania implemented successful EFTs for soil erosion and drought
- Political, socio-economic and cultural aspects impact EFTs policies with negative effects in Romania
- Re-focusing on EFTs is dependent on cultural and financial aspects.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 17 July 2018
Received in revised form 9 November 2018
Accepted 10 November 2018
Available online 12 November 2018

Editor: Damia Barcelo

Keywords:
Environmental friendly techniques
Historical evolution
Political changes
Socio-economic measures
Romanian traditions

ABSTRACT

Throughout the history of Romania, political decisions, socio-economic measures, and cultural (traditional) characters have affected the implementation of environment friendly techniques (EFTs) policies. In the context of this paper, EFTs can be defined as solutions for the use of land resources aiming the increasing of goods for meeting the changing human needs and with neutral or positive environmental impact. Changes in the political regime have always had a visible impact on the EFTs issue in Romania. EFTs has gone through several major phases. The political impact on EFTs implementation mainly affected sustainable land management (SLM) and to a small extent, at the end of the communist era and partly during the capitalist period, climate change mitigation. Throughout history, the political factor has dominated and influenced the capacity of the EFTs implementation process in responding to socio-economic stimuli. In addition, quality of life, rural-urban and urban-rural migrations, poverty, education level, and climate change adaptation have had impacts on the status of EFTs according to governance and political reflections. The agrarian reforms from the last two centuries, based on socio-economic demands, have strongly influenced the capacity to implement EFTs both positively and negatively. However, the cultural factor was least affected by political and socio-economic changes as a stability factor in ensuring continued implementation of the EFTs. Currently, there is a strong need to reconsider EFTs as sustainability tools for Romanian agriculture that can cope with climate change and sustainable land management (SLM)

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https://doi.org/10.1016/j.scitotenv.2018.11.160

demands. This paper presents a brief history of EFTs in Romania and their benefits in achieving SLM equilibrium, describing the impacts of political decisions, socio-economic measures, and cultural features on implementing ETFs policies.

1. Introduction

Increasing frequency of extreme weather events, such as floods and droughts, may be one of the most significant consequences of climate change in coming decades in countries in Eastern Europe, including Romania (Katz and Brown, 1992; Karl et al., 1993; Frei et al., 1998; Jones, 1999; Lehner et al., 2006; Kreibich et al., 2014).

An analysis of high-fatality natural disasters in Romania between 1900 and 2006 indicates the fact that about 90% are water-related, which means that these types of events are frequent and hazardous. Analysis also indicates that in Romania and other Eastern European countries, floods increased in magnitude during the period 1997 to 2006, while drought was severe at the beginning of the 1980s and gained momentum again from the late 1990s onwards (Adikari and Yoshitani, 2009; Gavrileteа, 2017). Climate data indicate that Romania has experienced an increase of about 0.5 °C in annual mean temperature during the last century, the value being even higher (up to 1 °C) in the South-East of the country. This climate warming effect, particularly in southern Romania, has been characterized by summer temperatures often exceeding 35–40 °C. However, no uniform long-term change in precipitation pattern has been detected in Romania, although there are some differences along a South-North gradient (Busuioc et al., 2007; Cazacioc, 2007; Anders et al., 2014; Arghius et al., 2016).

Implementing sustainable land management (SLM) and identifying viable solutions to respond to the effects of climate change is a subject of major importance for countries in Central and Eastern Europe (Rannow and Neubert, 2014). Against the historical background and political shifts in this part of Europe, SLM is strongly related to land-use changes and to the intensive use of grey infrastructure (Günal et al., 2015).

According to Zaharia and Antonescu (2014), SLM in Romania involves using land resources while considering an optimal equilibrium between economic growth, social inclusion and environmental protection. Severe climate change effects (especially a major increase in drought events) and major political-economic shifts generated by the transition from a centralized market to a market economy have affected this equilibrium (Stringer et al., 2009; Stringer and Harris, 2014; Günal et al., 2015). Thus, there is a need for new SLM measures (e.g., nature-based solutions (NBSs)) that simultaneously satisfy environmental, societal, and economic objectives while maintaining and enhancing natural capital (EC, 2015; Cohen-Shacham et al., 2016).

Agriculture is a sector where climate change requires a complex set of measures within the framework of a holistic approach, from different points of view and different perspectives (Falloon and Bets, 2010; Glover et al., 2014; Arbuckle et al., 2015). Since Romania has a significant rural population dependent on agricultural activities and one of the largest agricultural sectors in Eastern Europe, it has made strong efforts to achieve intensive and productive agriculture (mainly by land reclamation) in the past, particularly during the Communist era (Aceleanu et al., 2015; Barbu, 2015; Vasile et al., 2017).

The fall of the Communist regime in 1990 led to a series of radical changes in many economic sectors, with a transition from an old, centralized communist system to a new, free market-based system, which severely affected SLM policies (Balteanu and Popovici, 2010). Thus, adapting Romanian agriculture to a new climate and political challenges (including admission to the EU) requires a new approach, where NBSs might be a potential sustainable option.

Three key concepts proved to have significant impact on land management and climate change mitigation along Romania's history: EFTs, SLM and NBSs.

In the context of this paper, EFTs can be defined as solutions for the use of land resources aiming the increasing of goods for meeting the changing human demands and with neutral or positive environmental impact. Unfortunately, in many cases, these EFTs failed to ensure the long-term productive potential of land resources and the maintenance of their environmental functions (Mazurski, 1991; Botzan, 1994; Halbac-Cotoara-Zamfir, 2010).

A better understanding of EFTs effects and potential open the way for SLM implementation in Romania. SLM is defined as the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions (Motavalli et al., 2013).

Nature-based solutions are defined by IUCN (2012) as "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016). These nature-based solutions are ideally energy and resource-efficient, and resilient to change, but to be successful they must be adapted to local conditions (EC, 2015). Nature-based solutions (NBS) are a relatively recent environmental concept that emerged in the late 2000s (Eggermont et al., 2015). This concept is strongly connected to ideas such as natural systems agriculture (Jackson, 2002), natural solutions (Dudley et al., 2010), ecosystem-based approaches (Cowan et al., 2010; Keesstra et al., 2018; Thorslund et al., 2017), green infrastructure (Benedict and McMahon, 2006), ecological engineering (Borsje et al., 2011; Barrot et al., 2012), natural infrastructure (Smith and Barchiesi, 2009), and adaptation services (Lavorel et al., 2015).

In Romania, NBSs have been applied recently (XXIth Century) in rural areas (putting the accent mainly on re-greening activities and wetlands restoration), but also in urban areas, in the context of developing environmental action (Ioja et al., 2017). The most frequent approaches include green spaces, protection of green areas, and climate mitigation measures, grouped into several types of NBSs measures such as enhancing sustainable urbanization (Ioja et al., 2014; Kalantari et al., 2017), restoring degraded ecosystems, (Liquete et al., 2015), developing climate change adaptation and mitigation plans (Maes et al., 2015), and improving risk management and resilience (Ioja et al., 2017).

However, some questions arise, for example: How political regimes influenced EFTs and, more recently, NBSs implementation in Romania and what influence can have in the future? Are these EFTs reliable for SLM and climate change mitigation in Romania? Can those be efficient? Which is the influence of socio-economic factor? How important are the cultural aspects (traditions) in implementing EFTs and NBSs?

These questions are complex and require a detailed analysis of various factors (e.g., economic, social, political, cultural) affecting EFTs implementation throughout Romania's history. This paper aims to answer these questions using the following approaches:

- analysis of existing national scientific literature on EFTs and NBSs, (inter)national policy and planning documents, reports, relevant magazines
- data collection from disperse sources on examples of innovative and sustainable EFTs (a significant volume of data is available in old

books/manuscripts, some over 100 years old, published in Romanian and not easily accessible to foreign scientists)
- open discussions with several farmers (especially regarding the presentation of EFTs implemented in Romania)
- comparisons of statistical data (linked to EFTs and SLM concepts) from different periods and regions (e.g. dynamics of afforested areas, total areas covered by irrigation systems, total surfaces protected by forest belts etc.)

In the remainder of this paper, we present a brief history of EFTs in Romania. Learning from past experiences can be a good start for the future of EFTs and NBSs that can be used in other countries. The authors intend to continue studying EFTs concept and its implementation in Romania focusing on new challenges and opportunities which may arise from the perspectives of science, policy, and practice. They also intend to justify in a new article the possibility of implementing NBSs over the past centuries. The history is revealed by presenting and analyzing the impacts of different political regimes on EFTs and more recently NBSs policies, and the effect of socio-economic measures, technological development, and demographic decisions on implementing EFTs policies. Based on several case studies, we summarize the benefits of implementing EFTs in some Romanian regions, emphasizing the differences between 'grey' and 'green' approaches.

2. A historical approach to the environment friendly techniques in Romania

There are four major periods in the history of Romania, each characterized by a different political regime (ancient and medieval, monarchy, communism, capitalism), in which different EFTs have been applied. This research contributes to understand how political regimes determine EFTs and sustainable land management.

2.1. Ancient and medieval period

There are several examples of innovative and sustainable EFTs in these historical periods. These solutions were used on Romanian territory to remove water in excess. Strip-plowing, with alternating ridges and ditches between the bands, was one of the solutions devised by the Romans to improve drainage of land affected by water excess or flooding. They were found relevant when agriculture land was abandoned (Rodrigo-Comino et al., 2017) and in active olive plantations in Mediterranean Type ecosystems (Rodrigo-Comino et al., 2018a).

These solutions have persisted over time, with plowing in strips with alternating ridges still being used in Transylvania (Botzan, 1994; Sabau, 1997). In the 13th century, Templar Knights created lakes and ponds for fish and water reserves and reservoirs of water along the rivers, with the strategic aim of inundating some areas for defensive reasons. Due to the international situation and the position of Romania at the confluence of great empires, during the following centuries the areas affected by water in excess were no longer the subject of land restoration work, since marshy areas, with permanent or long ponds, represented effective obstacles to invaders (Sava and Wehry, 1967; Baltescu et al., 1972; Cazacu et al., 1985; Salvan, 1996).

The Commercial Commission of the Principality of Transylvania issued forestry instructions regarding the use of sterile, unproductive, ravine, and muddy land by dividing it between local inhabitants and imposing afforestation. The edges of ditches separating agricultural properties had to be planted with live horseradish and shrubs. Given the lack of wood in poor forest areas, the instructions foresaw the opportunity for afforestation of the northern slopes of hills and mountains across Transylvania with oak and possibly other species with rapid growth, because on such land agricultural crops produce poor yields (Sabau, 1946; Sotropa, 1975).

In Banat in 1743, the instructions given by Waldfortner (the first forest inspector of the region) demanded afforestation of lower regions located to the South and East of Banat and the Danube and Tisa meadows, areas where strategic interests required the creation of forests for border protection. In his instructions, which actually organized the forestry in Banat based on rigorous European standards, Waldfortner emphasized the importance of research into the establishment of forests, underlining that each of the species prefers a certain type of soil, depending on the moisture degree, the nature of the parent soil material, and the clay or of soil sand content (Costea, 1989; Rösler, 1999; Palaghianu, 2015; Palaghianu and Dutca, 2017).

2.2. Monarchy period

The implementation of innovative and sustainable EFTs was encouraged during this period (1866–1946). These solutions were applied mainly in the southern and eastern parts of the current Romanian territory, focusing on the excess water management to drought management and controlling desertification (Palaghianu and Dutca, 2017). The advance of sand dunes (200–250 m/year in the first half of the 19th century), which threatened several settlements in Southern Oltenia, required efficient measures for stopping this effect. The demand for protective windbreaks was first observed in the second half of the 19th century by Ion Ionescu from Brad, who made the first plantings for "shading against the wind" (Bucur, 2016). Thus, starting in 1852, the first forest belts appeared in this region and by the end of the century 25,000 ha (ha) were covered with acacia plantations. This approach represented the basic strategy in stopping soil erosion and wind erosion of sands until the beginning of 20th century (Chirita and Balanica, 1938; Ionescu Sisesti and Staicu, 1958; Bold, 1973; Palaghianu and Dutca, 2017).

After some extreme events (e.g., sand storms and severe droughts), starting in 1881, the problem of soil protection reached the government, which issued a draft law on agricultural field protection. This period was characterized by the reign of King Carol I (1866–1914), when Romania experienced continuous development even though the country's economy was mainly based on agriculture, concentrated on large properties without mechanization (van Meurs, 1999). However, Romania was one of the first countries in the world to acknowledge the importance of forest belts and implemented them on large areas to protect agricultural land from wind erosion (Chirita and Balanica, 1938; Palaghianu and Dutca, 2017).

The first "barriers collecting snow and wind dampeners", made with acacia, were established by the landlord Sălcudeanu in Marculesti-Ialomita (south-eastern Romania) between 1879 and 1891 (Rusescu, 1904). Between 1902 and 1907, on the crown estate at Sadova (Dolj), 50 km of forest belts were planted along the roads, to which 500 km were added around agricultural properties (25 ha fields) (Rusescu, 1907; Chirita and Balanica, 1938). These were the greatest field works in Romania at that time and were described as "works that can make an example for all European countries" (Dracea, 1937). An important role in forest barriers expansion was played by plantations around mansions and estates (e.g., on the former estate of Prince G. Stirbei at Bertestii de Jos, Braila, on fields with flying sand, in 1924). Droughts between 1928 and 1929 and 1933–1935 played an important role in convincing owners about the role of protection barriers. Thus between 1929 and 1936, 122 ha were planted with acacia in Buzau county, almost entirely on pasture, while between 1930 and 1937 another 425 ha were planted with acacia in Ialomita County, of which 40 ha were agricultural land. In 1938, the Regional Experimental Station "Dobrogea" was established, with headquarters in the Mangalia forest (formerly Comarova). One of its main objectives was experimentation on forest protection curtains on Dobrogea steppe, which is characterized by an arid climate (Catrina and Giurgiu, 1983; Stanescu, 1983; Palaghianu, 2015; Palaghianu and Dutca, 2017).

In the first half of 20th century, afforestation work continued in Southern Oltenia due to an increase in wind aggressiveness and to a more pronounced climate of drought and aridity. In 1910, Romanian Minister Grigore Antipa, in his efforts of justifying the need for preservation of natural Danube meadows, emphasized the importance of EFTs, measures which within an environmental sustainability framework can be actually classified as NBSs (Fig. 1).

He argued that:

- Ponds exert a positive moderating influence on the climate (comparable to that of forests) by acting as moisture and vapor condensation sources
- The ponds in the Danube meadow act as "valves", which are needed to prevent flood water rises that can cause flooding and breaking of dams in the case of historic highs
- Under their natural regime, the Danube's ponds when used for fish, have the highest productivity in Europe
- Using grey infrastructure for flood defense is very costly
- The meadows prevent loss of nutrients carried away by the Danube
- The meadows are suitable for development of willows, poplars, and even oak forest belts (Antipa, 1910; Antipa, 1913; Dan, 2014).

Unfortunately, these measures were put into practice only for a very short period of time (Botzan et al., 1991; Stoiculescu, 2008).

One of the EFTs implemented in western Romania for the management of excess water appears to have its origins in this historical period. From a historical perspective, excess water evacuation, which largely affects land in western Romania, was approached by two main methods: land drainage and examples of sustainable EFTs. While land drainage was intensively practiced later (during the Communist period), with very good results in agriculture, these EFTs were also implemented based on traditions transmitted by farming families, e.g., vineyard digging (Halbac-Cotoara-Zamfir et al., 2015). Vineyard digging is a very old land management practice observed in North-Western Romania (Eastern part of Finis commune, 5 km from Beius City), on the slopes of the Codru-Moma Mountains (green areas from the small figure) (Fig. 2). Within an environmental sustainability framework, these environment friendly traditions are examples of sustainable land management, which we could classify as NBSs currently.

Based on discussions with farmers, we concluded that this practice is at least 100 years old and it serves several purposes, mainly related to quantitative and qualitative aspects of grape production. Basically, it involves covering the lower part of the vine stems in autumn and uncovering them in spring, adding manure to increase soil fertility. The main aim of this practice is to protect the plant against winter cold.

During the discussions with several local vineyard owners, they reported that no ecological or environmental sustainability issues are considered in this practice. However, on analyzing operations (see Fig. 3a and b), we observed that vineyard digging provides additional benefits which can be considered part of SLM. For example, digging out the lower part of vine stems in spring creates a series of low dikes, which play an important role in harvesting rainwater, mitigating surface runoff, increasing water infiltration, and offering protection against soil erosion, although this can be a risk to increase soil erosion in sloping terrain (Rodrigo-Comino et al., 2017).

Since summers can be very dry in the area in discussion, these dikes provide support in water harvesting for vineyards, providing an important water source considering the lack of other resources in the immediate vicinity. Vineyard digging can also aim at optimizing wine production by reducing competition for water and nutrients between grapevines and weeds, and by preventing the outbreak of pests and diseases. Recently, Rodrigo-Comino et al. (2018b) found a similar response in Spanish vineyards where the ridge formed underneath the vines contributes to disconnect the flows and then to reduce the erosion rates.

However, these potential benefits are not the main reason for farmers practicing vineyard digging. In discussions with the vineyard owners, they emphasized that this practice of digging to maintain or enhance productivity is socially acceptable. By social acceptability, they referred to the rural mentality whereby practicing a specific task may be not a necessity, but a way to align with neighbors. Moreover, in a rural space traditions are very important, and very often indisputable. Based on the discussions with farmers, we concluded that even though vineyard digging is laborious work, requiring a large number of working hours, farmers feel that tradition must be observed and transmitted to future generations, not as a SLM practice but as a need to observe rural values.

All these aspects are very difficult to quantify and assess when studying the possibility of implement SLM practices based on local traditions. Moreover, most of these vineyards produce wine exclusively for

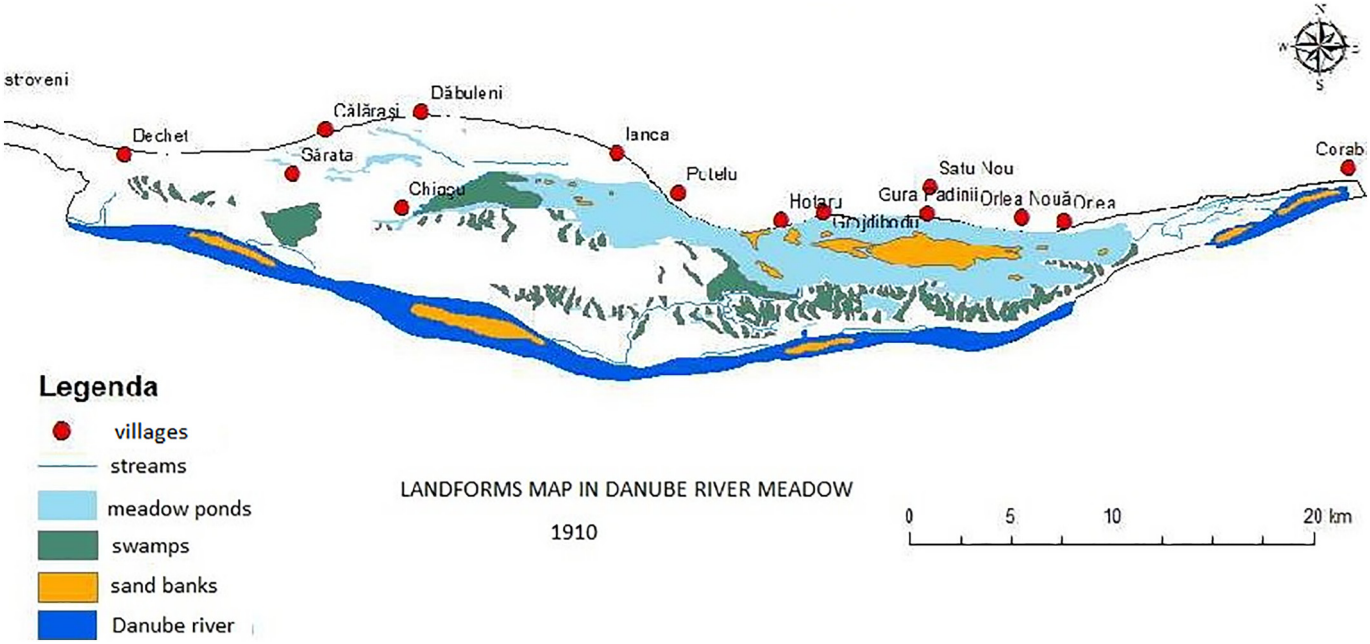

Fig. 1. Landforms map in Danube River Meadow in 1910 (Dan, 2014).

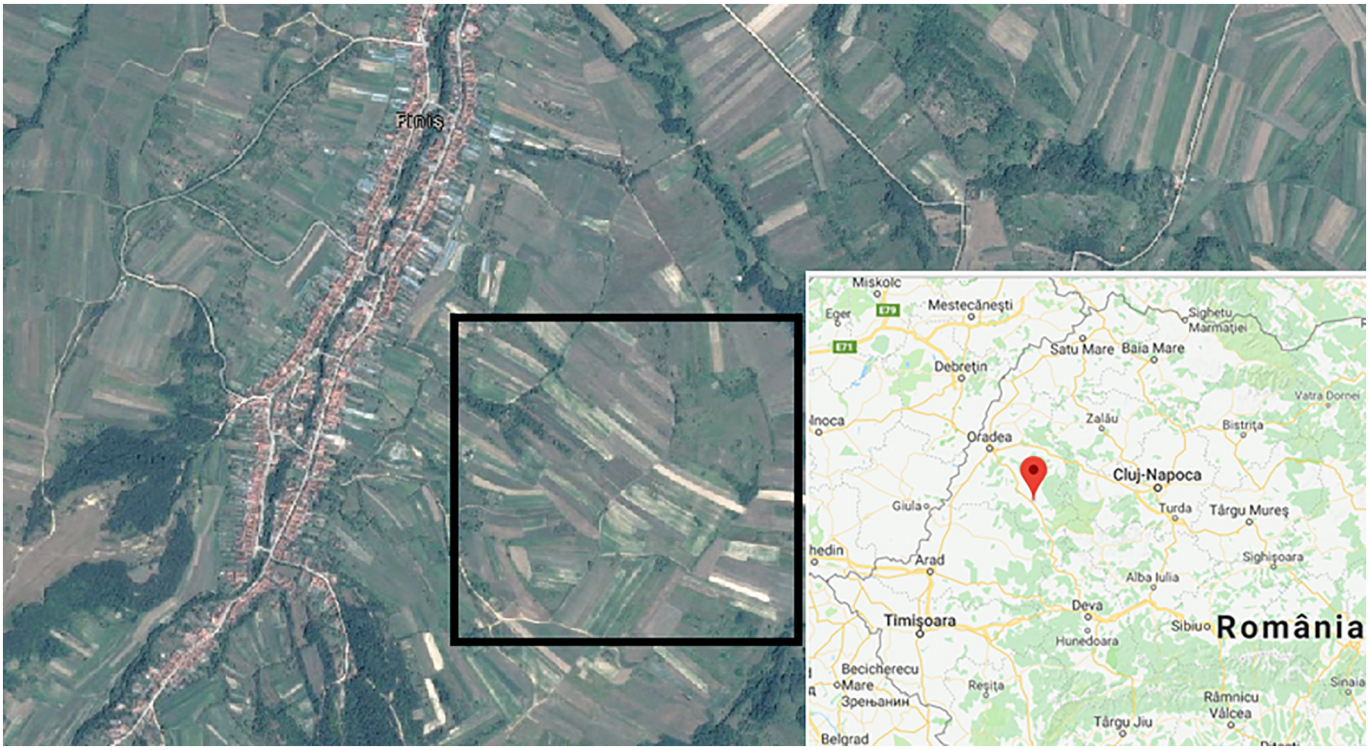

Fig. 2. Area located in NW Romania where vineyard digging was studied.

household consumption, so the commercial value is very small. With this lack of financial stimulant (except for avoiding the need to purchase wine) and considering that there are no environmental implications (there is no evidence of a need to use some ecosystem services based on this procedure), vineyard digging is unlikely to transition from traditional practice to SLM practice. However, adopting ecosystem services as an integral part of vineyard digging would provide a holistic view of vineyards and sustainability. As a result, optimizing ecosystem services delivery would improve long-term outcomes for vineyards.

Tolerating spontaneous vegetation in vineyards is another key aspect of vineyard digging (Fig. 4). However, very few cases with spontaneous vegetation in vineyards were identified and most of these not being considered a practice supplying ecosystem services but rather a reflection of negligent vineyard management. Moreover, establishing different types of cover crop mixes in vineyards and the effects on yield have not been sufficiently investigated.

2.3. Communist period

In Romania during the Communist period, land was considered to have no intrinsic value except to serve human needs (Mazurski, 1991). Centrally-administered production targets were established, but were not in harmony with land capacity and soil quality. Large areas in Southern Romania (where intensive agriculture is practiced) experience high temperatures and receive little precipitations. In these areas, the Thornthwaite aridity index is up to 65% (Păltineanu et al., 2007; Achim et al., 2012). Extensive desertification is occurring currently on these drylands. More than 100,000 ha are covered by sand dunes, representing the so-called Romanian Sahara (Niculescu et al., 2014) (Fig. 5).

This situation is the result of a series of poor political decisions starting from the end of the 1950s. The Communist regime intended to create in Southern Romania large agricultural areas served by irrigation systems and established the legislative path for clearing the protection belts. The acacia forests which stabilized the soil in risk areas were cleared (9000 ha by 1970) and large energy-intensive irrigation systems were installed (Pelin, 1971; Sandru, 1980). The original ecosystem (before deforestation) provided the necessary conditions for formation and manifestation of *baltaretul*, a local wind which blew from South to North during summer, carrying the vapors that formed over the almost 1000 km^2 of ponds in the river meadows. This contributed to air moistening, lower plant wilting point, and lower daytime temperatures in summer. However, this wind disappeared as a result of the massive deforestation. Moreover, the sand dunes which were previously stabilized became mobile, leading to imbalances in the local environment. This situation prompted a new action by the Communist authorities around 1960, which involved a new stage of forest plantations covering approximately 1600 ha (Nesu, 1999; Iordache, 2009; Halbac-Cotoara-Zamfir et al., 2015).

Thus, to achieve SLM in Romania (as it was understood in that period), special attention was paid to intensive use of fertilizers and land improvement schemes (large irrigation and land drainage systems). Only small surfaces were covered by forest belts or specific non-technical solutions to counteract the effects of different types of erosion (mainly aeolian). Overall, these measures appeared to create stable agricultural systems on more than 550,000 ha of sands and sandy soils (mainly Arenosols and Regosols), which were able to maintain land productivity in line with Communist policy targets. The main outcome of all these actions was that most sandy soils were stabilized and protected by vegetation (forests, pastures) and to a certain extent bound by humus layers. In other words, the natural balance on these lands contributed to a reduction in land degradation (Stringer et al., 2009; Stringer and Harris, 2014). These measures were considered sufficient and sustainable for intensive agriculture by the authorities. However, from an economic perspective, large irrigation system costs (covering more than 75,000 ha) were not feasible for a free market with no construction subsidies.

A large-scale action was the creation of a network of forest barriers in Dobrogea, in the Danube-Black Sea Canal region (the first stage of construction). The works were carried out between 1950 and 1961, in

Fig. 3. Vineyard with small dikes running parallel to the slope (a) and Vineyard with small dikes running perpendicular to the slope (b).

a special forestry program with five active sectors (Cernavodă, Medgidia, Poarta Albă, Palas-Constanţa, and M. Kogălniceanu). Unfortunately, results did not meet the expectations, due to less controllable factors. The network occupied an area of approximately 3000 ha, protecting an area of approximately 1 million ha (Lupe, 1950; Chirita, 1954; Lazarescu, 1963; Bakos, 1968). Those strategies result in a

Fig. 4. Vineyard with spontaneous vegetation.

Fig. 5. Unspoiled sandy dune in the Bechet area.

reduction in soil degradation and in the recovery of the soil services (Cerdà et al., 2018) as they reduce the connectivity of the flows and the sediment (Parsons et al., 2015; Masselink et al., 2017).

Unfortunately, in the second half of the 20th century, political and social issues had a negative impact on this balance. Between 1950 and 1989, large areas of arable land were confiscated from their owners by the Communist authorities and grouped into large-scale collective farms (Bold, 1973; Blujdea et al., 2006). The year 1962 marked the end for protective tree rows around fields. To enable expansion of agricultural land, two Decisions of the Council of Ministers (No. 257 and 385) approved removal of forest barriers. The consequence of this was destruction of the main tree row networks in Romania (Giurgiu, 2005).

The decision to cut most of the forest belts was in line with the policy of the Communist authorities for intensive agriculture based on increasing cereal production with the support of large land improvement systems (mainly irrigation). In the same period, in Romania grazing registered a significant expansion which increased land degradation severity.

2.4. Capitalist period

The fall of the Communist regime in Romania at the end of 1989 and the beginning of a period of transition to a market economy resulted in many changes regarding land use. There were permanent interactions between some key factors (political, economic, technological, demographic, natural). Some significant results of these changes were excessive fragmentation of the agricultural terrain, the emergence of very many individual, subsistence farms, and lack of development of services

Fig. 6. Degraded forest belt in Dolj County (southern Romania).

for agriculture (irrigation, fertilization, mechanization, etc.) (Balteanu et al., 2005; Popovici, 2008; Balteanu et al., 2013). The excessive fragmentation of the agricultural terrain proved to be fatal also for the remnants of forest belts (Fig. 6). Being unprotected, most of them were destroyed by unauthorized cutting.

Romania was then (and partly still is) characterized a significant rural population and has one of the largest agricultural sectors in Eastern Europe (Kuemmerle et al., 2009). The choice of implementing grey infrastructure instead of EFTs and/or NBSs to deal with the problem of the highly erodible sandy soils proved to be a mistake. In 1989, the irrigated area in Romania occupied a total area of over 3 million ha (Halbac-Cotoara-Zamfir, 2010). Maintenance of the irrigation systems had been a state responsibility but from 1990, due to the new government's lack of interest, all these systems started degrading, negatively affecting soil quality and land productivity. The South and South-Eastern regions of Romania, proned to extreme droughts and desertification, had been sustained by large areas provided with irrigation systems (almost 250,000 ha). Unfortunately, most of these systems were either destroyed or fell into an advanced stage of disrepair during this period. After 15 years of a market economy in Romanian agriculture, only about 3% of the 3 million ha of irrigated agricultural area remained. The result was that in cases of severe drought (e.g., the year 2000), cereal yield decreased by 40% compared to the previous year (Maracine et al., 2009; Balteanu and Popovici, 2010; Rusu and Simion, 2015).

After 1990, the Romanian National Forest Agency started a program of reforestation in the Southern regions (Fig. 7).

In a first stage, the program covered only government properties. Due to land fragmentation resulting from political decisions, massive efforts (e.g. organizing meetings with farmers; providing financial support to farmers interested in supporting afforestation activities etc.) were made to attract owners into afforestation associations. However, the memory of the Communist regime's confiscations was still recent, and the landowners viewed this initiative with no confidence. In addition, Romanians have a particularly sensitive sense of property, making it very difficult to assign them different tasks/roles on how they should use their land. Another impediment was lack of information on the existing legal framework allowing organization of associations for afforestation. Through information campaigns, over 5000 ha of land were planted, contributing to the agricultural and climate situation improvement in the respective area (re-create the necessary conditions for formation and manifestation of *baltaretul*) (Nuta, 2005; Turnock and Lawrence, 2007; Ciuvăţ et al., 2013; Pravalie, 2013).

A key element in restoring degraded lands in Romania was the establishment and development of Associations of Local Forest Owners (ALFOs). The members of ALFOs are eligible to access resources for afforestation and reforestation from different national and European funds. Since 2007, these ALFOs have developed forestry activities on an area of 1100 ha in Southern Romania (Marsani area), the main species planted there being *Robinia pseudoacacia*, which has the ability to improve degraded soils by nitrogen fixation and by adding organic matter (Burner et al., 2005; Von Holle et al., 2006). Another role of this species is to stabilize the soil surface and prevent the dune sands reformation and reactivation.

Other areas severely affected by drought in Southern, Eastern, and Western Romania also required forest belts to prevent land degradation. The establishment of these forest belts was based on studies involving analysis of factors such as lithology, topography, climate, hydrology, soil, and the human factor (Costachescu et al., 2010).

In addition, during the 1990s, Romania had a high number of unemployed people (due to very aggressive reforms), who moved to the countryside (rural areas absorbed a significant number of unemployed people) and started to rear animals, resulting in intensive grazing with no consideration of the relationship between land degradation and green cover (Fraser and Stringer, 2009). This migration from urban to rural areas imposed additional pressure on local fuel supplies, mainly fuel wood, which resulted in a further reduction of wooded areas.

Unfortunately, at national level, after the NBSs concept emerged (beginning of XXIth Century), there was little interest in promoting it. In addition, the situation worsened due to an emphasis on the quantity, and not the quality, of implemented measures. Other factors that negatively impacted NBSs implementation were the low level of knowledge of people involved in this field, with insufficient skills in ecosystem services, neglecting topics such as water management, risk management, biodiversity, and the uncertainties regarding NBSs financing (Ioja et al., 2014, 2017).

3. Discussion

A major obstacle in studying EFTs and NBSs concepts in Romania is that scientific literature on this subject is relatively poor and the

Fig. 7. Forest belts in southern Romania.

concepts of EFTs and NBSs were insufficiently studied. Currently, in Romania we can notice a lack of documented information on NBSs. The concept of NBSs was and is still described almost solely in official documents such as translations of European Union (EU) documents, different declarations issued by non-government organizations (NGOs), theories expounded in farming magazines. Throughout the history of Romania we were able to identify political decisions (resulting from changes in political regimes), socio-economic measures (transition from a centralized economy to a market economy based on competition), and cultural-traditional characteristics (affected by a series of factors, but unchanged in the critical aspects) which dictated (sustainable) land management. Regardless of the period and political system, EFTs and NBSs address two types of hazards: flooding and drought.

The NBSs concept is very difficult to identify as pure 'nature-based solutions' in Romanian scientific literature. A search for literature on the NBSs concept for Romania using Web of Science (WoS) and Scopus databases resulted in a very small number of scientific papers (max. 15). Extending the search to 'ecosystem-based approaches' (Keesstra et al., 2018; Thorslund et al., 2017; Cowan et al., 2010), which incorporates terms such as 'ecosystem services', 'green-blue infrastructure', 'ecological engineering' (Nesshöver et al., 2017; Kalantari et al., 2018) increased the success and the scientific sources were more accessible (almost 100 results in WoS and Scopus).

Even the Romania translation of nature-based solutions (*solutii bazate pe natura*) yielded very few results in a search using online search engines. However, the history of Romania, at least over the past 2000 years, includes numerous examples of EFTs. Within an environmental sustainability framework, this examples of sustainable and, sometimes, innovative ETFs we could classify as NBSs currently. Most of them are documented in books and manuscripts (Palaghianu, 2015; Palaghianu and Dutca, 2017). By going through and analyzing these examples, we identified three categories of factors as being determinant in the EFTs and, more recently, NBSs implementation process: political, socio-economic, and cultural.

Table 1
Impact of changes in the political regime on the interest for EFTs in Romania.

Historical period	Interest for innovative and sustainable EFTs	Explanations
Ancient period	High	EFTs were seen as cheap and available solutions for gaining high agricultural productions. Within an environmental sustainability framework these EFTs we could classify as NBSs currently.
Medieval period	Low	International situation (many conflicts and geo-strategically position) required these types of works to be abandoned for strategic defensive reasons
Monarchist period	High	EFTs were necessary for societal development, to increase the quality of life, due to the fact that the tactics based on attracting invaders in difficult areas (in terms of land) became unnecessary following the development of military technology. Within an environmental sustainability framework these EFTs we could classify as NBSs currently
Communist period	Low	Communist authorities had a strong interest in agricultural development based on state incentives and large irrigation systems
Capitalism	Increasing	Increased interest in EFTs and NBSs has resulted from the collapse of the communist market system, Romania's entry into competitive markets, 'accession to the European bodies, and the perceived need to establish a new harmony between man and nature

3.1. Political impact on EFTs implementation in Romania

Changes in the political regime have always had a visible impact on the EFTs issue in Romania. EFTs has gone through several major phases, as described in Table 1. The political impact on EFTs implementation mainly affected SLM and to a small extent to climate changes mitigation at the end of the communist era and partly during the capitalist period. Throughout history, the political factor has dominated and influenced the capacity of the EFTs implementation process in responding to socio-economic stimuli (Table 1).

3.2. Socio-economical impact on EFTs implementation in Romania

Quality of life, rural-urban and urban-rural migrations, poverty, education level, and climate change adaptation have had impacts on the status of EFTs according to governance and political reflections. In ancient and medieval times in particular, it was difficult to identify the real impact of socioeconomic factors. Such factors made their presence felt especially during the monarchy period and later, when individual and collective freedom allowed a different approach to the concept of EFTs. It should not be forgotten that Romania has long been a predominantly agrarian country, with most of the arable land belonging to a relatively small group of people whose major interest was to obtain profits from agricultural activities (van Meurs, 1999). Moreover, in the 150-year existence of the modern state, Romania has undergone 14 agrarian reforms (Stoenescu, 2001). These reforms, based on socio-economic necessities, have strongly influenced the capacity to implement EFTs both positively and negatively. In the past, the quality of life in Romania, the prevalence of poverty, and the degree of education were closely related to the quality of being landowner. Being a landowner increased the chances of a better life and a better education, which could result in greater interest for values such as environmental protection, ecological education, and interest in EFTs.

The impact of the communist regime in seizing land taken over by their owners only a few decades previously, will hamper any attempts at widespread re-introduction of EFTs in Romania. Following the relatively brutal passage from the communist to the capitalist system, land re-ownership by inhabitants in rural areas has led to the development of a highly developed sense of property. In many situations, this has resulted in the refusal to participate in collective activities on implementation of EFTs (e.g., creating protection tree rows). Following discussions with farmers, we concluded that, regardless of climate threats to SLM, in their view the right of ownership is non-negotiable and allows them to use their land irrespective of the consequences of their type and mode of land use.

3.3. Cultural impact on EFTs implementation in Romania

A positive aspect in the implementation of EFTs in Romania is the cultural factor, namely the role and importance of traditions at the level of the Romanian village. Over the centuries, smallholders have passed on farming traditions that, although not studied scientifically, have encouraged the ecological approach of SLM and climate change mitigation. The cultural factor was least affected by political and socio-economic changes as a stability factor in ensuring continued implementation of the EFTs.

There is still a surprising lack of information about studying, adopting, and implementing EFTs and, more recently, NBSs in Romania. Several forestry schools that opened during the monarchist period (mid-19th century) provided skilled staff for the forestry sector at that time. Later, these schools were upgraded to higher education colleges with the help of foreign specialists (mainly from France) (Stanescu, 1983; Turnock, 1988). After the Second World War, with the increasing interest of the Communist authorities in mechanized agriculture based on large land improvement systems, the Romanian higher education sector benefited from the establishment of a whole

series of engineering colleges focusing on technical measures, a system that still dominates today (Drobot and Bica, 2013).

However, during recent decades, by opening broad access to the EU, higher education institutions (and beyond) have begun research on NBSs. As a result, this concept has gained in importance, especially in the academic environment, but without achieving significant potential for major changes in national land management strategies in Romania.

4. Conclusions

Environment friendly techniques (EFTs) and Nature-based solutions (NBSs) represent useful tools for coping with climate change effects and supporting sustainable land management, bringing new challenges and opportunities from the perspectives of science, policy, and practice. However, implementation of EFTs and, more important, NBSs needs to consider political decisions, socio-economic measures, and cultural conditions. All these factors will influence the capacity of EFTs and NBSs to improve local ecological and social sustainability, mitigate climate change effects, and secure long-term productivity.

Given the political, socio-economic, and cultural context in Romania, EFTs, SLM and NBSs projects should be based on a well-balanced, clear, widely accepted, and implementable set of principles: i) embrace nature conservation norms; ii) can be implemented alone or in an integrated manner with other solutions to societal challenges; iii) maintain biological and cultural diversity and the ability of ecosystems to evolve over time; iv) NBSs should be perceived both opportunities and challenges and should be implemented in an integrated approach based on a very good understanding of ecosystem processes, stakeholder engagement, and inclusion of societal considerations.

References

Aceleanu, M.I., Molanescu, A.G., Craciun, L., Voicu, C., 2015. The status of Romanian agriculture and some measures to take. Theor. Appl. Econ. 2 (603), 123–138.

Achim, E., Manea, G., Vijulie, I., Cocos, O., Tirla, L., 2012. Ecological reconstruction of the plain areas prone to climate aridity through forest protection belts. Case study: Dabuleni town, Oltenia Plain, Romania. Procedia Environ. Sci. 14, 154–163. https://doi.org/10.1016/j.proenv.2012.03.015.

Adikari, Y., Yoshitani, J., 2009. Global Trend in Water-related Disasters—an Insight for Policymakers. UNESCO, 7 place de Fontenoy, 75352 Paris, France http//www.picapublish.com/WWAP/ICHARM/Trends%20in%20water%20disasters.pdf, Accessed date: 7 June 2018.

Anders, I., Stagl, J., Auer, I., Pavlik, D., 2014. Climate change in Central and Eastern Europe. In: Rannow, S., Neubert, M. (Eds.), Managing Protected Areas in Central and Eastern Europe Under Climate Change, Advances in Global Change Research 58. Springer, Dordrecht https://doi.org/10.1007/978-94-007-7960-0_2.

Antipa, G., 1910. The Danube Flood Plain (in Romanian). IAG, Bucharest.

Antipa, G., 1913. Three Memories on the Improving the Floodplain of the Danube (in Romanian). Independence, Bucharest.

Arbuckle, J.G., Morton, L.W., Hobbs, J., 2015. Understanding farmer perspectives on climate change adaptation and mitigation: the roles of trust in sources of climate information, climate change beliefs, and perceived risk. Environ. Behav. 47 (2), 205–234. https://doi.org/10.1177/0013916513503832.

Arghius, V., Rosian, G., Mihaiescu, R., Muntean, L., Arghius, C., 2016. Analysis of annual and seasonal air temperature and precipitation trends in south-eastern part of Romania in the context of climate change and desertification. 16th International Multidisciplinary Scientific GeoConference SGEM. SGEM2016 Conference Proceedings. Book 4 (2), pp. 227–234 https://doi.org/10.5593/SGEM2016/B42/S19.030.

Bakos, V., 1968. Aspects of Expanding Rapidly Growing Species (in Romanian). 83. Forest Magazine, pp. 469–473.

Balteanu, D., Popovici, E.A., 2010. Land-use changes and land degradation in post-socialist Romania. Rom. J. Geogr. 54 (2), 95–105.

Balteanu, D., Popescu, M., Ursanu, E.A., 2005. Land use in Romania under the Transition to the Market Economy. 54. Bucharest University Annals, pp. 99–112.

Balteanu, D., Dragota, C.S., Popovici, E.A., Dumitrascu, M., Kucsicsa, G., Grigorescu, I., 2013. Land use and crop dynamics related to climate change signals during the post-communist period in the south Oltenia, Romania. Proc. Rom. Acad. 15, 265–278.

Baltescu, M., Dunare, N., Binder, P., 1972. Barsei Country (in Romanian). Romanian Academy Publishing House, Bucharest.

Barbu, C.M., 2015. The Romanian "agricultural power" in the European context. Acad. J. Eur. Stud. 1 (3), 27–37.

Barrot, S., Lata, J.C., Lacroix, G., 2012. Meeting the relational challenge of ecological engineering within ecological sciences. Ecol. Eng. 45, 13–23. https://doi.org/10.1016/j.ecoleng.2011.04.006.

Benedict, M.A., McMahon, E.T., 2006. Green Infrastructure: Linking Landscapes and Communities. Island, Washington D.C.

Blujdea, V., Pahontu, C., Kleps, C., 2006. Third National Report on the Implementation of the United Nations Convention to Combat Desertification in Romania. ETS, Bucharest.

Bold, I., 1973. Evolution and the Role of Forest Plantations for the Protection of Agriculture in the Sands Area of Oltenia (in Romanian). 88. Forest Magazine, pp. 422–426.

Borsje, B.W., van Wesenbeeck, B.K., Dekker, F., Paalvast, P., Bourma, T.J., van Katwijk, M.M., de Vries, M.B., 2011. How ecological engineering can serve in coastal protection. Ecol. Eng. 37 (2), 113–122. https://doi.org/10.1016/j.ecoleng.2010.11.027.

Botzan, M., 1994. The Beginning of Hydrotechnics of Romania's Territory (in Romanian). Technical Publishing House, Bucharest.

Botzan, M., Haret, C., Stanciu, I., Buhociu, L., Vişinescu, I., 1991. Hydro-ameliorative Valuation of Romanian Danube Meadow and Delta (in Romanian). Centre for Didactic, Material and Agricultural Propaganda. Agricultural Propaganda Editorial Board, Bucharest.

Bucur, S.I., 2016. Protective Forest Belts in Romania – Regulatory Framework And Current Situation. A Case Study – Region South-Muntenia. 13(2). Agricultural Economics and Rural Development IAE, pp. 261–269.

Burner, D.M., Pote, D.H., Ares, A., 2005. Management effects on biomass and foliar nutritive value of *Robinia pseudoacacia* and *Gleditsia triacanthos f. intermis* in Arkansas, USA. Agrofor. Syst. 65, 207–214. https://doi.org/10.1007/s10457-005-0923-9.

Busuioc, A., Dumitrescu, A., Soare, E., Orzan, A., 2007. Summer anomalies in 2007 in the context of extremely hot and dry summers in Romania. Rom. J. Meteorol. 9 (1–2), 1–17.

Catrina, I., Giurgiu, V., 1983. Evolution of Scientific Research in the Field of Forestry in the Period 1933–1983 (in Romanian). 98. Forest Magazine, pp. 170–184.

Cazacioc, L., 2007. Spatial and temporal variability of extreme daily precipitation amounts in Romania. Rom. J. Meteorol. 9, 34–46.

Cazacu, E., Dobre, V., Mihnea, I., Pricop, G., Rosca, M., Sarbu, E., Stanciu, I., Wehry, A., 1985. Surface drainage (in Romanian). Ceres, Bucharest.

Cerdà, A., Rodrigo-Comino, J., Novara, A., Brevik, E.C., Vaezi, A.R., Pulido, M., ... Keesstra, S.D., 2018. Long-term impact of rainfed agricultural land abandonment on soil erosion in the Western Mediterranean basin. Prog. Phys. Geogr. 42 (2), 202–219.

Chirita, C.D., 1954. Improvement and Soil Cultivation in Land for Forest Crops in Central Dobrogea Steppe (in Romanian). State Agricultural and Forestry Publishing House, Bucharest.

Chirita, C., Balanica, T., 1938. Research on the Sands in southern Oltenia (in Romanian). 4. ICEF Annals (Series 1).

Ciuvăț, A.L., Abrudan, I.V., Blujdea, V., Marcu, C., Dinu, C., Enescu, M., Nuță, I.S., 2013. Distribution and peculiarities of black locust in Romania. J. For. Cinegetics 18 (32), 76–85.

Cohen-Shacham, E., Walters, G., Janzen, C., Maginnis, S. (Eds.), 2016. Nature-Based Solutions to Address Global Societal Challenges. IUCN, Gland, Switzerland https://doi.org/10.2305/IUCN.CH.2016.13.en (xiii + 97pp.).

Costachescu, C., Danescu, F., Mihaila, E., 2010. Windbreaking Forest Belts (in Romanian). Forestry Publishing House, Bucharest.

Costea, C., 1989. Economy and Leadership of Forest Enterprises (in Romanian). Ceres, Bucharest.

Working with nature to tackle climate change. In: Cowan, C., Epple, C., Korn, H., Schliep, R., Stadler, J. (Eds.), Report of the ENCA/BfN Workshop "Developing Ecosystem-based Approaches to Climate Change – Why, What and How". Bundesamt für Naturschutz (BfN), Bonn http://www.bfn.de/fileadmin/MDB/documents/service/Skript264.pdf, Accessed date: 1 June 2018.

Dan, M.D., 2014. Danube floodplain between Ostroveni and Corabia. A Study of Land Assessment for Floodplain Restoration. Bucharest University, Bucharest.

Dracea, M., 1937. A few notes about the culture of exotic trees (in Romanian). Forest Magazine 2, 194–198.

Drobot, R., Bica, I., 2013. Hydrotechnic education in Romania (in Romanian). Hydrotechnics 58 (10—11), 7–15.

Dudley, N., Stolton, S., Belokurov, A., Krueger, L., Lopoukhine, N., MacKinnon, K., Sandwith, T., Sekhran, N., 2010. Natural Solutions: Protected Areas Helping People Cope With Climate Change. World Wide Fund For Nature (WWF), Gland.

Eggermont, H., Balian, E., Azevedo, J.M.N., Beumer, V., Brodin, T., Claudet, J., Fady, B., Grube, M., Keune, H., Lamarque, P., Reuter, K., Smith, M., van Ham, C., Weisser, W.W., Le Roux, X., 2015. Nature-based solutions: new influence for environmental management and research in Europe. Gaia 24, 243–248. https://doi.org/10.14512/gaia.24.4.9.

European Commission (EC), 2015. Towards an EU Research and Innovation policy agenda for nature-based solutions & re-naturing cities. Final Report of the Horizon2020 Expert Group on Nature-based Solutions and Re-naturing Cities. European Commission, Brussels.

Falloon, P., Bets, R., 2010. Climate impacts on European agriculture and water management in the context of adaptation and mitigation—the importance of an integrated approach. Sci. Total Environ. 408 (23), 567–587. https://doi.org/10.1016/j.scitotenv.2009.05.002.

Fraser, E.D.G., Stringer, L.C., 2009. Explaining agricultural collapse: macro-forces, micro-crises and the emergence of land use vulnerability in southern Romania. Glob. Environ. Chang. 19, 45–53. https://doi.org/10.1016/j.gloenvcha.2008.11.001.

Frei, C., Schar, C., Luthi, D., Davies, H.C., 1998. Heavy precipitation processes in a warmer climate. Geophys. Res. Lett. 25 (9), 1431–1434. https://doi.org/10.1029/98GL51099.

Gavriletea, M.D., 2017. Catastrophe risk management in Romania and Transylvania' specifics. Issues for national and local administrations. Econ. Res. 30 (1), 761–776. https://doi.org/10.1080/1331677X.2017.1314817.

Giurgiu, V., 2005. About the Relationship Between Forests and Environmental Changes (in Romanian). Romanian Academy Publishing House, Bucharest.

Glover, J.L., Champion, D., Daniels, K.J., Dainty, A.J.D., 2014. An Institutional Theory perspective on sustainable practices across the dairy supply chain. Int. J. Prod. Econ. 152, 102–111. https://doi.org/10.1016/j.ijpe.2013.12.027.

Günal, H., Korucu, T., Birkas, M., Özgöz, E., Halbac-Cotoara-Zamfir, R., 2015. Threats to sustainability of soil functions in Central and Eastern Europe. Sustainability 7 (2), 2161–2188. https://doi.org/10.3390/su7022161.
Halbac-Cotoara-Zamfir, R., 2010. Efficient Technical and Economically Drainage Studies for Fields With Humidity Excess. UPT, Timisoara.
Halbac-Cotoara-Zamfir, R., Gunal, H., Birkas, M., Rusu, T., Brejea, R., 2015. Successful and unsuccessful stories in restoring despoiled and degraded lands in Eastern Europe. Adv. Environ. Biol. 9 (23), 368–376.
Ioja, C.L., Gradinaru, S.R., Onose, D.A., Vanau, G.O., Tudor, A.C., 2014. The potential of school green areas to improve urban green connectivity and multifunctionality. Urban For. Urban Green. 13 (4), 704–713. https://doi.org/10.1016/j.ufug.2014.07.002.
Ioja, C.L., Nita, M., Onose, D., Hossu, A., 2017. Nature-based Solutions Into Environmental Action Plans: Case Study Romania, Dresden Nexus Conference, 17–19 May, Germany. http://www.dresden-nexus-conference.org/wp-content/uploads/2017/06/B4-Ioja.pdf, Accessed date: 2 June 2018.
Ionescu Sisesti, G., Staicu, I., 1958. Agrotechnics (in Romanian). Agro-forestry Publishing House, Bucharest.
Iordache, C., 2009. Evolution of the number of inhabitants in South Oltenia agro-region and the impact on the forest fund. Natura Montenegrina 8 (3), 173–181.
IUCN, 2012. Livelihoods and Landscape Strategy: Results and Reflections. IUCN, Gland.
Jackson, D.L., 2002. The Farm as Natural Habitat: Reconnecting Food Systems With Ecosystems. Island, Washington D.C.
Jones, J.A.A., 1999. Climate change and sustainable water resources: placing the threat of global warming in perspective. Hydrol. Sci. J. 44 (4), 541–557. https://doi.org/10.1080/02626669909492251.
Kalantari, Z., Ferreira, C.S.S., Walsh, R.P.D., Ferreira, A.J.D., Destouni, G., 2017. Urbanization development under climate change: hydrological responses in a peri-urban Mediterranean catchment. Land Degrad. Dev. 28 (7), 2207–2221. https://doi.org/10.1002/ldr.2747.
Kalantari, Z., Ferreira, C.S.S., Keesstra, S., Destouni, G., 2018. Nature-based solutions for flood-drought risk mitigation in vulnerable urbanizing parts of East-Africa. Curr. Opin. Environ. Sci. Health 2018 (5), 73–78. https://doi.org/10.1016/j.coesh.2018.06.003.
Karl, T., Quayle, R.G., Groisman, P.I., 1993. Detecting climate variations and change: new challenges for observing data management systems. J. Clim. 6, 1481–1494. https://doi.org/10.1175/1520-0442.
Katz, W.R., Brown, G., 1992. Extreme events in changing climate: variability is more important than averages. Clim. Chang. 21, 289–302. https://doi.org/10.1007/BF00139728.
Keesstra, S., Nunes, J., Novara, A., Finger, D., Avelar, D., Kalantari, Z., Cerdà, A., 2018. The superior effect of nature based solutions in land management for enhancing ecosystem services. Sci. Total Environ. 610–611, 997–1009. https://doi.org/10.1016/j.scitotenv.2017.08.077.
Kreibich, H., van den Bergh, J.C.J.M., Bouwer, L.M., Bubeck, P., Ciavola, P., Green, C., Hallegatte, S., Logar, I., Meyer, V., Schwarze, R., Thieken, A.H., 2014. Costing natural hazards. Nat. Clim. Chang. 4, 303–306. https://doi.org/10.1038/nclimate2182.
Kuemmerle, T., Müller, D., Griffiths, P., Rusu, M., 2009. Land use change in Southern Romania after the collapse of socialism. Reg. Environ. Chang. 9, 1–12. https://doi.org/10.1007/s10113-008-0050-z.
Lavorel, S., Colloff, M.J., McIntyre, S., Doherty, M.D., Murphy, H.T., Metcalfe, D.J., Dunlop, M., Williams, R.J., Wise, R.M., Williams, K.J., 2015. Ecological mechanisms underpinning climate adaptation services. Glob. Chang. Biol. 21 (1), 12–31. https://doi.org/10.1111/gcb.12689.
Lazarescu, C., 1963. Ecological Requirements of Rapidly Growing Species (in Romanian). 78. Forest Magazine, pp. 330–333.
Lehner, B., Doll, P., Alcamo, J., Henrichs, T., Kaspar, F., 2006. Estimating the impact of global change on flood and drought risks in Europe: a continental integrated analysis. Clim. Chang. 75, 273–299. https://doi.org/10.1007/s10584-006-6338-4.
Liquete, C., Kleeschulte, S., Dige, G., Maes, J., Grizzetti, B., Olah, B., Zulian, G., 2015. Mapping green infrastructure based on ecosystem services and ecological networks: a Pan-European case study. Environ. Sci. Pol. 54, 268–280. https://doi.org/10.1016/j.envsci.2015.07.009.
Lupe, I., 1950. Keep and Restore Forest Protection Curtains (in Romanian). 65. Forest Magazine, pp. 57–58.
Maes, J., Barbosa, A., Baranzelli, C., Zulian, G., Silva, F.B., Vandecasteele, I., Hiederer, R., Liquete, C., Paracchini, M.L., Mubareka, S., Jacobs-Crisioni, C., Castillo, C.A., Lavalle, C., 2015. More green infrastructure is required to maintain ecosystem services under current trends in land-use change in Europe. Landsc. Ecol. 30 (3), 517–534. https://doi.org/10.1007/s10980-014-0083-2.
Maracine, N., Maracineanu, F., Constantin, E., Campeanu, S., 2009. Present and Future in the Romanian Irrigation Facilities Operation Management. 66(2). UASVM Horticulture Transactions, pp. 557–561.
Masselink, R., Temme, A.J.A.M., Giménez, R., Casalí, J., Keesstra, S.D., 2017. Assessing hillslope-channel connectivity in an agricultural catchment using rare-earth oxide tracers and random forests models. Cuadernos de Investigación Geográfica 43 (1), 17–39.
Mazurski, K.R., 1991. Communism and the environment. Forum Appl. Res. Public Policy 5, 39–44.
Motavalli, P., Nelson, K., Udawatta, R., Jose, S., Bardhan, S., 2013. Global achievements in sustainable land management. Int. Soil Water Conserv. Res. 1 (1), 1–10. https://doi.org/10.1016/S2095-6339(15)30044-7.
Nesshöver, C., Assmuth, T., Irvine, K.N., Rusch, G.M., Waylen, K.A., Delbaere, B., Haase, D., Jones-Walters, L., Keune, H., Kovacs, E., Krauze, K., Külvik, M., Rey, F., van Dijk, J., Vistad, O.I., Wilkinson, M.E., Wittmer, H., 2017. The science, policy and practice of nature-based solutions: an interdisciplinary perspective. Sci. Total Environ. 579, 1215–1227. https://doi.org/10.1016/j.scitotenv.2016.11.106.
Nesu, I., 1999. Forest Belts for Lands Protection (in Romanian). Star Tipp Publishing House, Slobozia.
Niculescu, M., Grecu, F., Popescu, C., 2014. The corology, ecology and phytosociology of the sands plant communities and natural habitats in the sandy area from Dabuleni, Dolj County – Romania. 14th International Multidisciplinary Scientific GeoConference SGEM Book. 5(2), pp. 697–702. https://doi.org/10.5593/SGEM2014/B52/S20.092.
Nuta, S., 2005. Structural and functional characteristics of the forest protection curtains of the agricultural field in southern Oltenia (in Romanian). ICAS Ann. 48, 161–169.
Palaghianu, C., 2015. Afforestation (in Romanian). Electronic Course Support. "Stefan cel Mare" University of Suceava, Romania http://www.silvic.usv.ro/cursuri/impaduriri.pdf, Accessed date: 15 May 2018.
Palaghianu, C., Dutca, I., 2017. Afforestation and reforestation in Romania: history, current practice and future perspectives. Reforesta (4), 54–68 https://doi.org/10.21750/REFOR.4.05.44.
Păltineanu, C., Mihăilescu, I.F., Seceleanu, I., Dragotă, C.S., Vasenciuc, F., 2007. Using aridity indexes to describe some climate and soil features in Eastern Europe: a Romanian case study. Theor. Appl. Climatol. 90, 263–274. https://doi.org/10.1007/s00704-007-0295-3.
Parsons, A.J., Bracken, L., Poeppl, R.E., Wainwright, J., Keesstra, S.D., 2015. Introduction to special issue on connectivity in water and sediment dynamics. Earth Surf. Process. Landf. 40 (9), 1275–1277.
Pelin, A., 1971. Forest Protection Curtains in Sadova-Corabia Irrigation System (in Romanian). ISJ Dolj, Craiova.
Popovici, E.A., 2008. The main factors of land use change in post-socialist Romania (in Romanian). Geogr. Mag. 14–15, 123–128.
Pravalie, R., 2013. Considerations on spatial and temporal dynamics of forest ecosystems in southern Oltenia. Studia UBB Geogr. 58 (2), 179–188.
Rannow, S., Neubert, M., 2014. Managing Protected Areas in Central and Eastern Europe under Climate Change, Advances in Global Change Research. 58. Springer, Berlin.
Rodrigo-Comino, J., Brings, C., Iserloh, T., Casper, M.C., Seeger, M., Senciales, J.M., Ries, J.B., 2017. Temporal changes in soil water erosion on sloping vineyards in the Ruwer-Mosel Valley. The impact of age and plantation works in young and old vines. J. Hydrol. Hydromech. 65 (4), 402–409.
Rodrigo-Comino, J., Taguas, E., Seeger, M., Ries, J.B., 2018a. Quantification of soil and water losses in an extensive olive orchard catchment in Southern Spain. J. Hydrol. 556, 749–758.
Rodrigo-Comino, J.R., Keesstra, S.D., Cerdà, A., 2018b. Connectivity assessment in Mediterranean vineyards using Improved Stock Unearthed Method, LiDAR and soil erosion field surveys. Earth Surf. Process. Landf. 43 (10), 2193–2206.
Rösler, R., 1999. Forest history in Romania. A General Survey. News of Forest History. 28 (1). IUFRO Research Group (S 6.07.00).
Rusescu, D.R., 1904. Draft Law for Forest Renewal, Restoration of Mountains and Extinction and Correction of the country's Torrents (in Romanian) (Bucharest).
Rusescu, D.R., 1907. The Issue of Artificial Afforestation in Romania (in Romanian) (Romania).
Rusu, M., Simion, G., 2015. Farm structure adjustments under the irrigation systems rehabilitation in the southern plain of Romania: a first step towards sustainable development. Carpathian J. Earth Environ. Sci. 10 (3), 91–100.
Sabau, V., 1946. Evolution of the forestry economy in Romania (in Romanian). Forestry Progress Society, Bucharest.
Sabau, N.C., 1997. The Impact of Hydroameliorative Works on Soils From Ier Valley Perimeter (in Romanian). Oradea University Printing House, Oradea.
Salvan, F., 1996. The Life of Villages From Barsa Country Villages in the Middle Ages (XIII – XVII Centuries) (in Romanian). Romanian Academy, Bucharest.
Sandru, I., 1980. Carpathian Landscapes in Dacia. 12(3). Terra, pp. 3–7.
Sava, I., Wehry, A., 1967. Hydroameliorations (in Romanian). EDP, Bucharest.
Smith, M., Barchiesi, S., 2009. Environment as Infrastructure - Resilience to Climate Change Impacts on Water Through Investments in Nature. IUCN, Gland http://cmsdata.iucn.org/downloads/iucn_environment_as_infrastructure_1.pdf, Accessed date: 8 June 2018.
Sotropa, V., 1975. The District Borders on Nasaud (in Romanian). Dacia Publishing House, Cluj-Napoca.
Stanescu, V., 1983. On the anniversary of one century of Romanian forestry education (in Romanian). Forest Magazine 98, 185–194.
Stoenescu, A.M., 2001. The History of the coup d'etat in Romania (in Romanian). I–IV. RAO, Bucharest.
Stoiculescu, C.D., 2008. The Ecological Reconstruction of the Floodable Danube Area (in Romanian). WWF, Bucharest.
Stringer, L.C., Harris, A., 2014. Land degradation in Dolj County, Southern Romania: environmental changes, impacts and responses: land degradation in Romania: impacts and responses. Land Degrad. Dev. 25, 17–28. https://doi.org/10.1002/ldr.2260.
Stringer, L.C., Scrieciu, S.S., Reed, M.S., 2009. Biodiversity, land degradation, and climate change: participatory planning in Romania. Appl. Geogr. 29, 77–90. https://doi.org/10.1016/j.apgeog.2008.07.008.
Thorslund, J., Jarsjö, J., Jaramillo, F., Jawitz, J.W., Manzoni, S., Basu, N.B., Chalov, S.R., Cohen, M.J., Creed, I.F., Goldenberg, R., Hylin, A., Kalantari, Z., Koussis, A.D., Lyon, S.W., Mazi, K., Mård, J., Persson, K., Pietron, J., Prieto, C., Quin, A., Van Meter, K., Destouni, G., 2017. Wetlands as large-scale nature-based solutions: status and challenges for research, engineering and management. Ecol. Eng. https://doi.org/10.1016/j.ecoleng.2017.07.012.
Turnock, D., 1988. Woodland conservation: the emergence of rational land use policies in Romania. GeoJournal 17, 413–433.
Turnock, D., Lawrence, A., 2007. Romania's forest under transition: changing priorities in management, conservation and ownership. Geographica Timisiensis 16 (1–2), 5–28.
Van Meurs, W., 1999. Land reform in Romania – a never-ending story. South-East Eur. Rev. 2, 109–122.

Vasile, A.J., Mieila, M., Panait, M., 2017. Transformations of the Romanian agricultural paradigm under domestic economic policy reforms: an analysis during 1960–2011. Land Use Policy 67, 288–297. https://doi.org/10.1016/j.landusepol.2017.06.008.

Von Holle, B., Joseph, K.A., Largay, E.F., Lohnes, R.G., 2006. Facilitations between the introduced nitrogen-fixing tree, *Robinia pseudoacacia*, and non-native plant species in the glacial outwash upland ecosystem of Cape Cod, MA. Biodivers. Conserv. 15, 2197–2215. https://doi.org/10.1007/s10531-004-6906-8.

Zaharia, A., Antonescu, A.G., 2014. Strategic measures for reducing land-use emissions in Romania, Proceedings of the 8th International Management Conference "Management Challenges for Sustainable Development", November 6th–7th, 2014, Bucharest, Romania.